CLAIMS

What is claimed is:

1. A droplet ejection apparatus having a head unit including a plurality of droplet ejection heads each ejecting liquid within a cavity through a nozzle in the form of droplets by driving an actuator by way of a driving circuit, said apparatus comprising:

ejection failure detecting means for detecting an ejection failure of said droplet ejection heads and a cause thereof; and

recovery means for performing recovery processing depending on the cause of the ejection failure if said ejection failure detecting means detects the ejection failure.

2. The droplet ejection apparatus according to Claim 1, wherein said recovery means includes:

wiping means for performing, with the use of a wiper, a wiping process on nozzle surfaces of said droplet ejection heads where said nozzles are aligned;

flushing means for performing a flushing process by which the droplets are preliminarily ejected through said nozzles by driving said actuators; and

pumping means for performing a pump-suction process with the use of a pump connected to a cap covering the nozzle surfaces of said droplet ejection heads.

3. The droplet ejection apparatus according to Claim 2, wherein:

the cause of an ejection failure detectable by said ejection failure detecting means includes:

intrusion of an air bubble inside said cavity;

thickening of the liquid in a vicinity of said nozzle; and

adhesion of dust in a vicinity of an outlet of said nozzle; and

said recovery means performs the pump-suction process by said pumping means in a case of the intrusion of an air bubble, at least one of the flushing process by said flushing means and the pump-suction process by said pumping means in a case of the thickening of the liquid, and at least the wiping process by said wiper in a case of the adhesion of dust.

4. The droplet ejection apparatus according to Claim 3, wherein:

when said ejection failure detecting means detects the intrusion of an air bubble and the thickening of the liquid that need said pump-suction process in more than one droplet ejection head of said head unit, said recovery means performs the pump-suction process for the droplet ejection heads where the intrusion of an air bubble and the thickening of the liquid are detected.

5. The droplet ejection apparatus according to Claim 1, wherein:

each of said droplet ejection heads includes a diaphragm that is displaced when the actuator is driven; and

said ejection failure detecting means detects a residual vibration of said diaphragm and determines an ejection failure of said droplets based on a vibration pattern of the detected residual vibration of said diaphragm.

6. The droplet ejection apparatus according to Claim 5, wherein:

said ejection failure detecting means includes judging means for judging at least one of a presence and an absence of an ejection failure of the droplets in the corresponding droplet ejection head based on the vibration pattern of the residual vibration of said diaphragm, and judging the cause of the ejection failure upon judging the presence of the ejection failure of the droplets in said droplet ejection head.

7. The droplet ejection apparatus according to Claim 6, wherein:

the vibration pattern of the residual vibration of said diaphragm includes a cycle of the residual vibration.

8. The droplet ejection apparatus according to Claim 7, wherein:

said judging means judges that:

an air bubble has intruded inside said cavity when the cycle of the residual vibration of said diaphragm is shorter than a predetermined first period;

the liquid has thickened in the vicinity of said nozzle when the cycle of the residual vibration of said diaphragm is longer than a predetermined second period; and

dust is adhering in the vicinity of the outlet of said nozzle when the cycle of the residual vibration of said diaphragm is longer than said first period and shorter than said second threshold.

9. The droplet ejection apparatus according to Claim 5, wherein:

said ejection failure detecting means includes an oscillation circuit and said oscillation circuit oscillates based on an electric capacitance component of said actuator that varies with the residual vibration of said diaphragm.

10. The droplet ejection apparatus according to Claim 9, wherein:

said oscillation circuit forms a CR oscillation circuit from the electric capacitance component of said actuator and a resistance component of a resistor element connected to said actuator.

11. The droplet ejection apparatus according to Claim 9, wherein:

said ejection failure detecting means includes an F/V converting circuit that generates a voltage waveform of the residual vibration of said diaphragm from a predetermined signal group generated based on a change of an oscillation frequency in an output signal from said oscillation circuit.

12. The droplet ejection apparatus according to Claim 11, wherein:

said ejection failure detecting means includes a waveform shaping circuit that shapes the voltage waveform of the residual vibration of said

diaphragm generated in said F/V converting circuit into a predetermined waveform.

13. The droplet ejection apparatus according to Claim 12, wherein said waveform shaping circuit includes:

DC component removing means for removing a direct current component from the voltage waveform of the residual vibration of said diaphragm generated in said F/V converting circuit; and

a comparator that compares the voltage waveform, from which the direct current component has been removed by said DC component removing means with a predetermined voltage value,

said comparator generating and outputting a rectangular wave based on the voltage comparison.

14. The droplet ejection apparatus according to Claim 13, wherein:

said ejection failure detecting means includes measuring means for measuring a cycle of the residual vibration of said diaphragm from said rectangular wave generated in said waveform shaping circuit.

15. The droplet ejection apparatus according to Claim 14, wherein:

said measuring means has a counter, and measures at least one of a time between rising edges and a time between a rising edge and a falling edge of said rectangular wave by counting pulses of a reference signal with said counter.

16. The droplet ejection apparatus according to Claim 1, further comprising:

switching means for switching a connection of said actuator from said driving circuit to said ejection failure detecting means after an ejection operation of the droplets is performed by driving said actuator.

17. The droplet ejection apparatus according to Claim 16, wherein:

said droplet ejection apparatus comprises more than one ejection failure detecting means and more than one switching means; and

the switching means corresponding to said droplet ejection head that has performed the droplet ejection operation switches the connection of said actuator from said driving circuit to a corresponding ejection failure detecting means, and said switched ejection failure detecting means detects an ejection failure of said droplets.

18. The droplet ejection apparatus according to Claim 16, wherein:

said switching means comprises more than one unit switching means corresponding to said droplet ejection heads, respectively;

said ejection failure detecting means further includes detection determining means for determining for which nozzle among said nozzles detection of an ejection failure of said droplets is to be performed; and

said switching means switches a connection of said actuator from said driving circuit to said ejection failure detecting means after the ejection operation of said droplets is performed by driving said actuator corresponding

to the nozzle of said droplet ejection head determined by said detection determining means.

19. The droplet ejection apparatus according to Claim 1, wherein:

said ejection failure detecting means detects an ejection failure of said droplets at a time of at least one of the droplet ejection operation during the flushing process and the droplet ejection operation during a print operation by said nozzle as a target of detection.

20. The droplet ejection apparatus according to Claim 1, wherein:

said actuator comprises an electrostatic actuator.

21. The droplet ejection apparatus according to Claim 1, wherein:

said actuator comprises a piezoelectric actuator using a piezoelectric effect of a piezoelectric element.

22. The droplet ejection apparatus according to Claim 1, further comprising:

storage means for storing the cause of an ejection failure of said droplets detected by said ejection failure detecting means, in connection with said nozzle as the target of detection.

23. A droplet ejection apparatus, provided with a plurality of droplet ejection heads each ejecting a liquid through a nozzle communicating with said cavity in the form of droplets by changing an internal pressure of said

cavity filled with the liquid by driving an actuator with a driving circuit, for ejecting the droplets through said nozzles while scanning said droplet ejection heads relatively with respect to a droplet receptor so that the droplets land on said droplet receptor, said apparatus comprising:

ejection failure detecting means for detecting an ejection failure of the droplets through said nozzles and a cause thereof;

recovery means for performing recovery processing for said droplet ejection heads to eliminate the cause of the ejection failure of the droplets; and

storage means for storing a nozzle where the ejection failure is detected by said ejection failure detecting means, in connection with the cause thereof,

wherein if detection by said ejection failure detecting means is performed for all of said nozzles and the presence of a failing nozzle in which an ejection failure is occurring is detected, recovery processing depending on the cause of the ejection failure is performed by said recovery means at least for said failing nozzle, after which detection by said ejection failure detecting means is performed again by forcing said failing nozzle alone to perform a droplet ejection operation.

24. The droplet ejection apparatus according to Claim 23, wherein said recovery means includes:

wiping means for performing a wiping process by which nozzle surfaces of said droplet ejection heads, where said nozzles are aligned, are wiped with a wiper;

flushing means for performing a flushing process by which the droplets are preliminarily ejected through said nozzles by driving said actuators; and

pumping means for performing a pump-suction process with the use of a pump connected to a cap covering the nozzle surfaces of said droplet ejection heads.

25. The droplet ejection apparatus according to Claim 24, wherein:

the cause of an ejection failure detectable by said ejection failure detecting means includes:

intrusion of an air bubble inside said cavity;

thickening of the liquid in a vicinity of said nozzle; and

adhesion of dust in a vicinity of an outlet of said nozzle; and

said recovery means performs the pump-suction process by said pumping means if the cause of the ejection failure of said failing nozzle is the intrusion of an air bubble, at least one of the flushing process by said flushing means and the pump-suction process by said pumping means if the cause of the ejection failure of said failing nozzle is the thickening of the liquid, and at least the wiping process by said wiper if the cause of the ejection failure of said failing nozzle is the adhesion of dust.

26. A droplet ejection apparatus, provided with a plurality of droplet ejection heads each ejecting a liquid through a nozzle communicating with said cavity in the form of droplets by changing an internal pressure of said cavity filled with the liquid by driving an actuator with a driving circuit, for

ejecting the droplets through said nozzles while scanning said droplet ejection heads relatively with respect to a droplet receptor so that the droplets land on said droplet receptor, said apparatus comprising:

ejection failure detecting means for detecting an ejection failure of the droplets through said nozzles and a cause thereof;

recovery means for performing recovery processing for said droplet ejection heads to eliminate the cause of the ejection failure of the droplets; and

storage means for storing a nozzle where the ejection failure is detected by said ejection failure detecting means, in connection with the cause thereof,

wherein:

said recovery means includes flushing means for performing a flushing process by which the droplets are preliminarily ejected through said nozzles by driving said actuators; and

if the presence of a failing nozzle in which an ejection failure is occurring is detected when detection by said ejection failure detecting means is performed for all of said nozzles, the flushing process is performed for said failing nozzle alone, after which detection by said ejection failure detecting means is performed again by forcing said failing nozzle alone to perform a droplet ejection operation, and when the presence of a re-failing nozzle in which the ejection failure has not been eliminated is detected, recovery processing depending on the cause of the ejection failure of said re-failing nozzle is performed by said recovery means at least for said re-failing nozzle, after which detection by said ejection failure detecting means is performed

once again by forcing said re-failing nozzle alone to perform the droplet ejection operation.

27. The droplet ejection apparatus according to Claim 26, wherein said recovery means further includes:

wiping means for performing a wiping process by which nozzle surfaces of said droplet ejection heads, where said nozzles are aligned, are wiped off by a wiper; and

pumping means for performing a pump-suction process with the use of a pump connected to a cap covering the nozzle surfaces of said droplet ejection heads.

28. The droplet ejection apparatus according to Claim 27, wherein:

the cause of an ejection failure detectable by said ejection failure detecting means includes:

intrusion of an air bubble inside said cavity;

thickening of the liquid in a vicinity of said nozzle; and

adhesion of dust in a vicinity of an outlet of said nozzle; and

said recovery means performs the pump-suction process by said pumping means if the cause of the ejection failure of said re-failing nozzle is at least one of the intrusion of an air bubble and the thickening of the liquid, and at least the wiping process by said wiper if the cause of the ejection failure of said re-failing nozzle is the adhesion of dust.

29. The droplet ejection apparatus according to Claim 24, wherein:

said recovery means performs the flushing process for each of said nozzles after the recovery processing depending on the cause of the ejection failure is performed.

30. The droplet ejection apparatus according to Claim 24, wherein:

said wiping means is adapted to perform the wiping process separately for plural sets of nozzle groups, so that when performing the wiping process depending on the cause of the ejection failure of said failing nozzle or said re-failing nozzle, said wiping means performs the wiping process only for a nozzle group including said failing nozzle or said re-failing nozzle.

31. The droplet ejection apparatus according to Claim 24, wherein:

said pumping means is adapted to perform the pump-suction process separately for plural sets of nozzle groups, so that when performing the pump-suction process depending on the cause of the ejection failure of said failing nozzle or said re-failing nozzle, said pumping means performs the pump-suction process only for a nozzle group including said failing nozzle or said re-failing nozzle.

32. The droplet ejection apparatus according to Claim 30, wherein:

said plural sets of nozzle groups have different droplets to be ejected.

33. The droplet ejection apparatus according to Claim 23, further comprising:

informing means for informing a detection result when a result of detection by said ejection failure detecting means detects a nozzle with an ejection failure.

34. The droplet ejection apparatus according to Claim 23, wherein:

the actuator of each of said droplet ejection heads has a diaphragm that can be displaced so as to change an internal pressure of said cavity; and

said ejection failure detecting means detects residual vibration of said diaphragm and detects an ejection failure based on a vibration pattern of the detected residual vibration of said diaphragm.

35. The droplet ejection apparatus according to Claim 34, wherein:

said actuator comprises an electrostatic actuator.

36. The droplet ejection apparatus according to Claim 34, wherein:

said actuator comprises a piezoelectric actuator using a piezoelectric effect of a piezoelectric element.

37. The droplet ejection apparatus according to Claim 34, wherein:

said ejection failure detecting means includes an oscillation circuit and said oscillation circuit oscillates based on an electric capacitance component of said actuator that varies with the residual vibration of said diaphragm.

38. The droplet ejection apparatus according to Claim 37, wherein:

said oscillation circuit forms a CR oscillation circuit from the electric capacitance component of said actuator and a resistance component of a resistor element connected to said actuator.

39. The droplet ejection apparatus according to Claim 23, wherein:

the actuator of each of said droplet ejection heads has a heating element that can film boil the liquid filled in said cavity;

each of said droplet ejection heads further includes a diaphragm that is displaced elastically in association with a change in internal pressure of said cavity, and an electrode provided opposite said diaphragm; and

said ejection failure detecting means detects residual vibration of said diaphragm and detects an ejection failure based on a vibration pattern of the detected residual vibration of said diaphragm.

40. The droplet ejection apparatus according to Claim 39, wherein:

said ejection failure detecting means includes an oscillation circuit, and said oscillation circuit oscillates based on a variance with time of an electric capacitance of a capacitor comprising said diaphragm and said electrode, associated with the residual vibration of said diaphragm.

41. The droplet ejection apparatus according to Claim 40, wherein:

said oscillation circuit forms a CR oscillation circuit from an electric capacitance component of said capacitor and a resistance component of a resistor element.

42. The droplet ejection apparatus according to Claim 34, wherein:

the vibration pattern of the residual vibration of said diaphragm includes a cycle of said residual vibration.

43. The droplet ejection apparatus according to Claim 34, wherein:

said ejection failure detecting means includes judging means for judging at least one of a presence and an absence of an ejection failure of the droplets in said droplet ejection head based on the vibration pattern of the residual vibration of said diaphragm, and judging the cause of the ejection failure upon judging the presence of the ejection failure of the droplets in said droplet ejection head.

44. The droplet ejection apparatus according to Claim 43, wherein:

said judging means judges that:

an air bubble has intruded inside said cavity when the cycle of the residual vibration of said diaphragm is shorter than a first predetermined period;

the liquid has thickened in the vicinity of said nozzle when the cycle of the residual vibration of said diaphragm is longer than a second predetermined period; and

dust is adhering in the vicinity of the outlet of said nozzle when the cycle of the residual vibration of said diaphragm is longer than said first predetermined period and shorter than said second predetermined period.

45. The droplet ejection apparatus according to Claim 37, wherein:

said ejection failure detecting means includes an F/V converting circuit that generates a voltage waveform of the residual vibration of said diaphragm from a predetermined signal group generated based on a change of an oscillation frequency in an output signal from said oscillation circuit.

46. The droplet ejection apparatus according to Claim 45, wherein:

said ejection failure detecting means includes a waveform shaping circuit that shapes the voltage waveform of the residual vibration of said diaphragm generated in said F/V converting circuit into a predetermined waveform.

47. The droplet ejection apparatus according to Claim 46, wherein said waveform shaping circuit includes:

DC component removing means for removing a direct current component from the voltage waveform of the residual vibration of said diaphragm generated in said F/V converting circuit; and

a comparator that compares the voltage waveform, from which the direct current component has been removed by said DC component removing means, with a predetermined voltage value,

said comparator generating and outputting a rectangular wave based on the voltage comparison.

48. The droplet ejection apparatus according to Claim 47, wherein:

said ejection failure detecting means includes measuring means for measuring a cycle of the residual vibration of said diaphragm from said rectangular wave generated in said waveform shaping circuit.

49. The droplet ejection apparatus according to Claim 48, wherein:

said measuring means has a counter, and measures at least one of a time between rising edges and a time between a rising edge and a falling edge of said rectangular wave by counting pulses of a reference signal with said counter.

50. An ejection failure recovery method for a droplet ejection apparatus having a head unit including a plurality of droplet ejection heads each ejecting liquid within a cavity through a nozzle in the form of droplets by driving an actuator with a driving circuit, said method comprising:

detecting an ejection failure of said droplet ejection heads and a cause thereof; and

performing recovery processing depending on the cause of the ejection failure in a case where the ejection failure is detected.

51. The droplet ejection apparatus according to Claim 27, wherein:

said recovery means performs the flushing process for each of said nozzles after the recovery processing depending on the cause of the ejection failure is performed.

52. The droplet ejection apparatus according to Claim 27, wherein:

said wiping means is adapted to perform the wiping process separately for plural sets of nozzle groups, so that when performing the wiping process depending on the cause of the ejection failure of said failing nozzle or said re-failing nozzle, said wiping means performs the wiping process only for a nozzle group including said failing nozzle or said re-failing nozzle.

53. The droplet ejection apparatus according to Claim 27, wherein:

said pumping means is adapted to perform the pump-suction process separately for plural sets of nozzle groups, so that when performing the pump-suction process depending on the cause of the ejection failure of said failing nozzle or said re-failing nozzle, said pumping means performs the pump-suction process only for a nozzle group including said failing nozzle or said re-failing nozzle.

54. The droplet ejection apparatus according to Claim 31, wherein:

said plural sets of nozzle groups have different droplets to be ejected.

55. The droplet ejection apparatus according to Claim 26, further comprising:

informing means for informing a detection result when a result of detection by said ejection failure detecting means detects a nozzle with an ejection failure.

56. The droplet ejection apparatus according to Claim 26, wherein:

the actuator of each of said droplet ejection heads has a diaphragm that can be displaced so as to change an internal pressure of said cavity; and

said ejection failure detecting means detects residual vibration of said diaphragm and detects an ejection failure based on a vibration pattern of the detected residual vibration of said diaphragm.

57. The droplet ejection apparatus according to Claim 56, wherein:

said actuator comprises an electrostatic actuator.

58. The droplet ejection apparatus according to Claim 56, wherein:

said actuator comprises a piezoelectric actuator using a piezoelectric effect of a piezoelectric element.

59. The droplet ejection apparatus according to Claim 56, wherein:

said ejection failure detecting means includes an oscillation circuit and said oscillation circuit oscillates based on an electric capacitance component of said actuator that varies with the residual vibration of said diaphragm.

60. The droplet ejection apparatus according to Claim 59, wherein:

said oscillation circuit forms a CR oscillation circuit from the electric capacitance component of said actuator and a resistance component of a resistor element connected to said actuator.

61. The droplet ejection apparatus according to Claim 26, wherein:

the actuator of each of said droplet ejection heads has a heating element that can film boil the liquid filled in said cavity;

each of said droplet ejection heads further includes a diaphragm that is displaced elastically in association with a change in internal pressure of said cavity, and an electrode provided opposite said diaphragm; and

said ejection failure detecting means detects residual vibration of said diaphragm and detects an ejection failure based on a vibration pattern of the detected residual vibration of said diaphragm.

62. The droplet ejection apparatus according to Claim 61, wherein:

said ejection failure detecting means includes an oscillation circuit, and said oscillation circuit oscillates based on a variance with time of an electric capacitance of a capacitor comprising said diaphragm and said electrode, associated with the residual vibration of said diaphragm.

63. The droplet ejection apparatus according to Claim 62, wherein:

said oscillation circuit forms a CR oscillation circuit from an electric capacitance component of said capacitor and a resistance component of a resistor element.

64. The droplet ejection apparatus according to Claim 56, wherein:

the vibration pattern of the residual vibration of said diaphragm includes a cycle of said residual vibration.

65. The droplet ejection apparatus according to Claim 56, wherein:

said ejection failure detecting means includes judging means for judging at least one of a presence and an absence of an ejection failure of the droplets in said droplet ejection head based on the vibration pattern of the residual vibration of said diaphragm, and judging the cause of the ejection failure upon judging the presence of the ejection failure of the droplets in said droplet ejection head.

66. The droplet ejection apparatus according to Claim 65, wherein:

said judging means judges that:

an air bubble has intruded inside said cavity when the cycle of the residual vibration of said diaphragm is shorter than a first predetermined period;

the liquid has thickened in the vicinity of said nozzle when the cycle of the residual vibration of said diaphragm is longer than a second predetermined period; and

dust is adhering in the vicinity of the outlet of said nozzle when the cycle of the residual vibration of said diaphragm is longer than said first predetermined period and shorter than said second predetermined period.

67. The droplet ejection apparatus according to Claim 40, wherein:

said ejection failure detecting means includes an F/V converting circuit that generates a voltage waveform of the residual vibration of said

diaphragm from a predetermined signal group generated based on a change of an oscillation frequency in an output signal from said oscillation circuit.

68. The droplet ejection apparatus according to Claim 67, wherein:

said ejection failure detecting means includes a waveform shaping circuit that shapes the voltage waveform of the residual vibration of said diaphragm generated in said F/V converting circuit into a predetermined waveform.

69. The droplet ejection apparatus according to Claim 68, wherein:

said waveform shaping circuit includes:

DC component removing means for removing a direct current component from the voltage waveform of the residual vibration of said diaphragm generated in said F/V converting circuit; and

a comparator that compares the voltage waveform, from which the direct current component has been removed by said DC component removing means, with a predetermined voltage value,

said comparator generating and outputting a rectangular wave based on the voltage comparison.

70. The droplet ejection apparatus according to Claim 69, wherein:

said ejection failure detecting means includes measuring means for measuring a cycle of the residual vibration of said diaphragm from said rectangular wave generated in said waveform shaping circuit.

71. The droplet ejection apparatus according to Claim 69, wherein:

said measuring means has a counter and measures at least on of a time between rising edges and a time between a rising edge and a falling edge of said rectangular wave by counting pulses of a reference signal with said counter.

72. A droplet ejection apparatus having a head unit including a plurality of droplet ejection heads each ejecting liquid within a cavity through a nozzle in the form of droplets by driving an actuator by way of a driving circuit, said apparatus comprising:

an ejection failure detector which detects an ejection failure of said droplet ejection heads and a cause thereof; and

a recovery device which performs recovery processing depending on the cause of the ejection failure if said ejection failure detector detects the ejection failure.

73. A droplet ejection apparatus, provided with a plurality of droplet ejection heads each ejecting a liquid through a nozzle communicating with said cavity in the form of droplets by changing an internal pressure of said cavity filled with the liquid by driving an actuator with a driving circuit, for ejecting the droplets through said nozzles while scanning said droplet ejection heads relatively with respect to a droplet receptor so that the droplets land on said droplet receptor, said apparatus comprising:

an ejection failure detector which detects an ejection failure of the droplets through said nozzles and a cause thereof;

a recovery device which performs recovery processing for said droplet ejection heads to eliminate the cause of the ejection failure of the droplets; and

a storage device which stores a nozzle where the ejection failure is detected by said ejection failure detector, in connection with the cause thereof,

wherein if detection by said ejection failure detector is performed for all of said nozzles and the presence of a failing nozzle in which an ejection failure is occurring is detected, recovery processing depending on the cause of the ejection failure is performed by said recovery device at least for said failing nozzle, after which detection by said ejection failure detector is performed again by forcing said failing nozzle alone to perform a droplet ejection operation.

74. A droplet ejection apparatus, provided with a plurality of droplet ejection heads each ejecting a liquid through a nozzle communicating with said cavity in the form of droplets by changing an internal pressure of said cavity filled with the liquid by driving an actuator with a driving circuit, for ejecting the droplets through said nozzles while scanning said droplet ejection heads relatively with respect to a droplet receptor so that the droplets land on said droplet receptor, said apparatus comprising:

an ejection failure detector which detects an ejection failure of the droplets through said nozzles and a cause thereof;

a recovery device for performing recovery processing for said droplet ejection heads to eliminate the cause of the ejection failure of the droplets; and

a storage device which stores a nozzle where the ejection failure is detected by said ejection failure detector, in connection with the cause thereof,

wherein:

said recovery device includes a flusher for performing a flushing process by which the droplets are preliminarily ejected through said nozzles by driving said actuators; and

if the presence of a failing nozzle in which an ejection failure is occurring is detected when detection by said ejection failure detector is performed for all of said nozzles, the flushing process is performed for said failing nozzle alone, after which detection by said ejection failure detector is performed again by forcing said failing nozzle alone to perform a droplet ejection operation, and when the presence of a re-failing nozzle in which the ejection failure has not been eliminated is detected, recovery processing depending on the cause of the ejection failure of said re-failing nozzle is performed by said recovery device at least for said re-failing nozzle, after which detection by said ejection failure detector is performed once again by forcing said re-failing nozzle alone to perform the droplet ejection operation.